Utility Earthquake Mitigation

Considerations
Requirements
Actions

Donald W. Shaw P.E.
National Earthquake Conference
April 13,2012

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Impacts on Electricity Supply from the 2010 Chilean Earthquake

Araneda, Rudnick,Mocarquer and Miquel
IEEE Powercon Oct 2010

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Chilean Codes include strict seismic standards (IEEE 693) for all electricity infrastructure

February 27, 2010 an 8.8 Richter scale earthquake hit the central part of Chile

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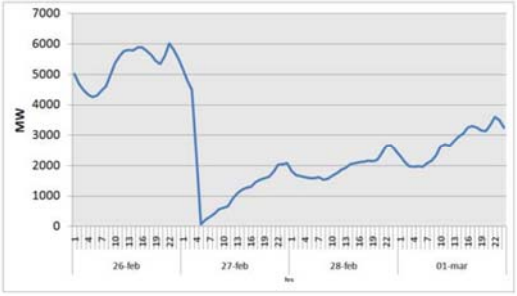
Electricity Supply Impacts

Generation

- Immediate Loss of 4,522 MW
- 693 MW of Generation from 16 plants required extended time for repair (6.1% of total installed capacity)



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Electricity Supply Impacts

TRANSMISSION DAMAGES

	Number	Damaged	%
Substations	46	12	26%
Transmission lines (km.)	7280	1.6	0.02%

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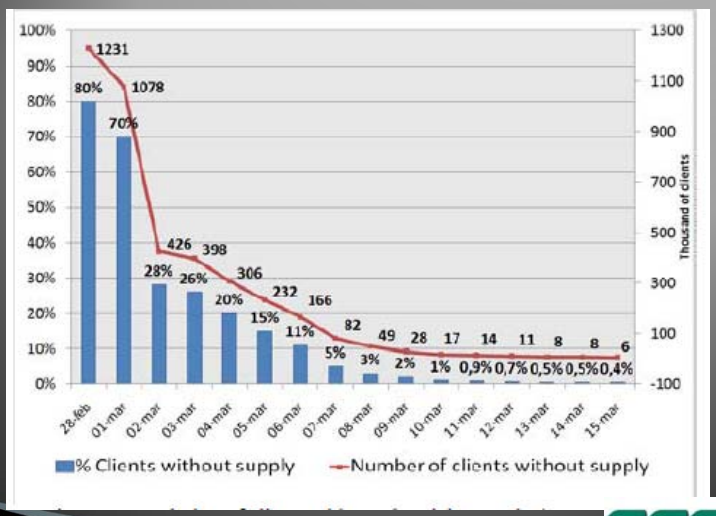
Electricity Supply Impacts

Distribution



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Electricity Supply Impacts

Operations

- Communication systems severely impacted
- Ten year old SCADA system determined inadequate for the event
- Subsequent global blackout one week later caused by protection control cable damaged in the original quake

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New Madrid Power Plant

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New Madrid Plant Seismic Considerations

- Unit 1 was designed to conform to the 1967 – Uniform Building Code for a Zone 3 seismic area
- Unit 2 was designed to conform to the 1970 – Uniform Building Code for a Zone 3 seismic area
- Static design earthquake forces were determined in accordance with the Uniform Building Code for Zone 3

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Earthquake Probabilities for New Madrid Seismic Zone

	Richter Scale	30 year Probability
Turbine Trip	6.3	90%
Turbine /Gen Damage	7.1	67%
Structural Damage	7.6	25%
Total Loss	8.3	3%

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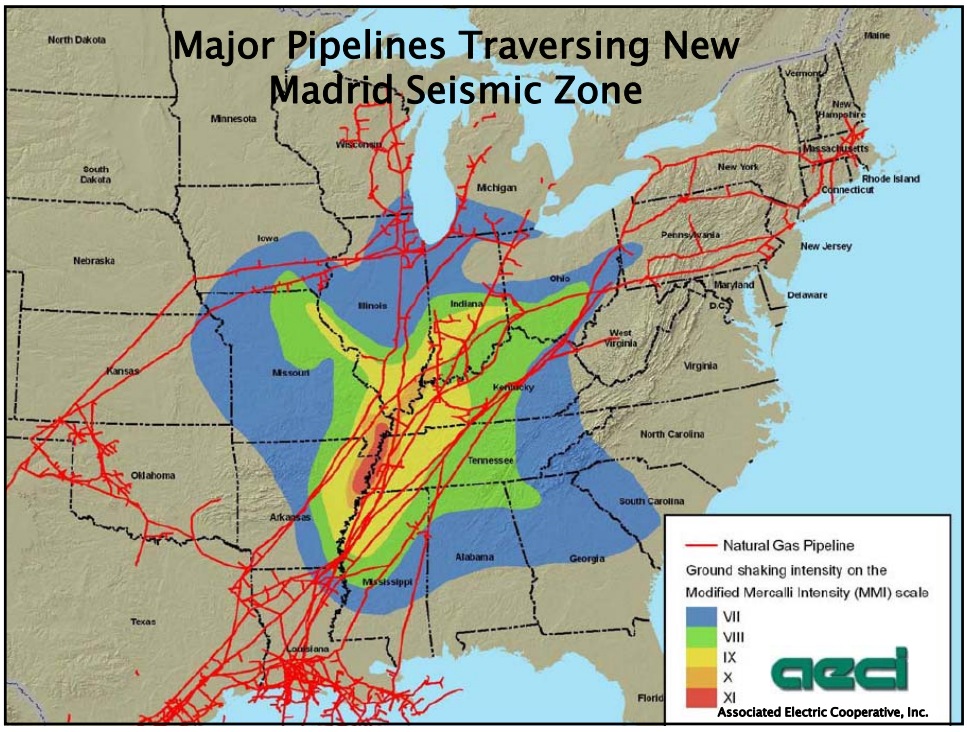

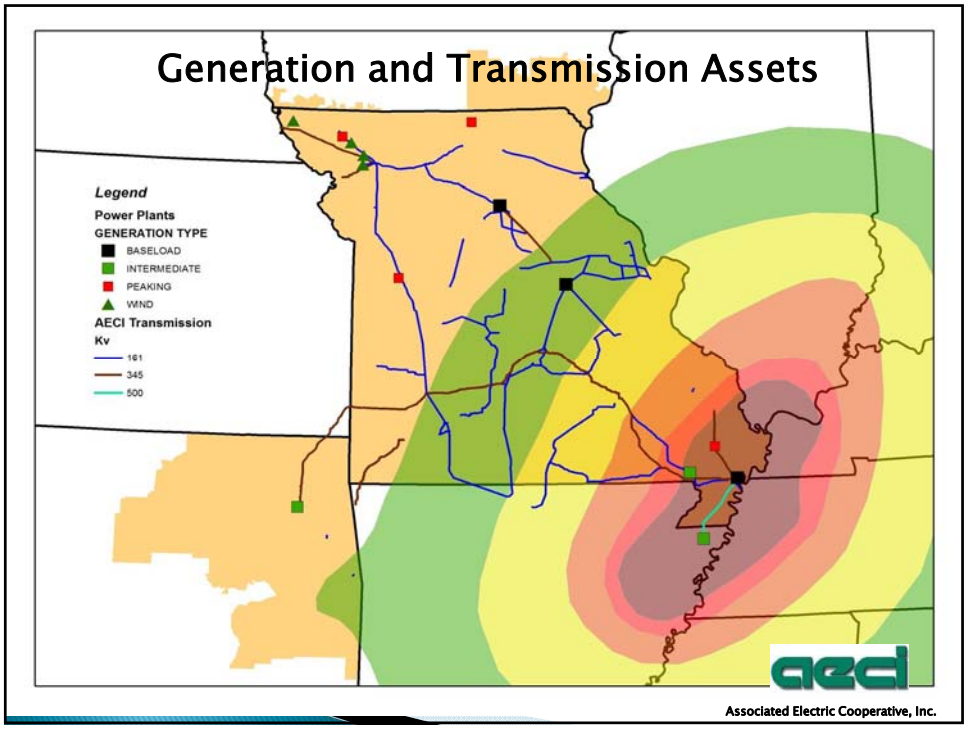
Generation and Transmission Assets
Legend
Power Plants
GENERATION TYPE
BASELOAD
INTERMEDIATE
PEAKING
WIND
AECI Transmission
Kv
161
345
500
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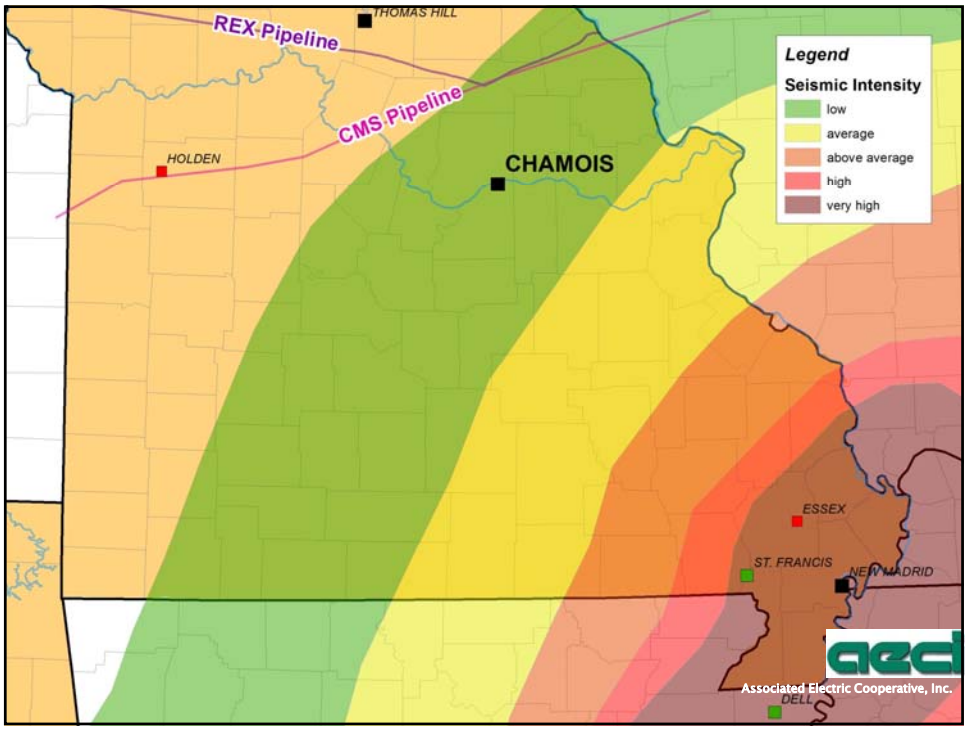
REX Pipeline
THOMAS HILL
CMS Pipeline
HOLDEN
CHAMOIS
Legend
Seismic Intensity
low
average
above average
high
very high
ESSEX
ST. FRANCIS
NEW MADRID
DELL
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Estimated AECI Long-Term Generation Loss Following Magnitude 7.0 Quake

Base Load Generation Loss New Madrid	1200 MW
Intermediate Generation Loss St Francis and Dell	1081 MW
Peaking Generation Loss Essex	107 MW
Total Generation Loss	2281 MW

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Seismic Design *Considerations* for Electric Facilities

- IEEE 693- Seismic Qualification Standard (69kV and above)
- ASCE Structure Design Guide (MOP 113)
- ASCE/SEI 7-10 for substation buildings

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Seismic Design *Requirements* for Electric Facilities

- Nuclear Regulatory Commission Approval
- Rural Utilities Service-Bulletin 1724E-300
- PUC- None
- Federal- None

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FEMA

National Level Exercise (NLE) 2011

AECI Facilities Involved with 2011 NLE

- New Madrid Plant
- St. Francis Plant
- Dell Plant
- Essex Plant
- Headquarters

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Meal
Ready-to-Eat, Individual
MENU NO. 14
VEGETABLE MANICOTTI
Vegetarian
Meal
Ready-to-Eat, Individual
SOPAKCO Packaging
Mullins, SC 29574-1047
MENU NO. 19
POT ROAST
WITH VEGETABLES
Meal
Ready-to-Eat, Individual
SOPAKCO Packaging
Mullins, SC 29574-1047
U.S. GOVERNMENT PROPERTY
Meal
Ready-to-Eat, Individual
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AECI Earthquake Action Plan
Action Plan
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AECI Emergency Rescue Training
aecl
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AECI Construction
aecl
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Dell Power Plant Fuel Oil,
Foundation Upgrade
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Equipment
Foundation
Bolts
aecl
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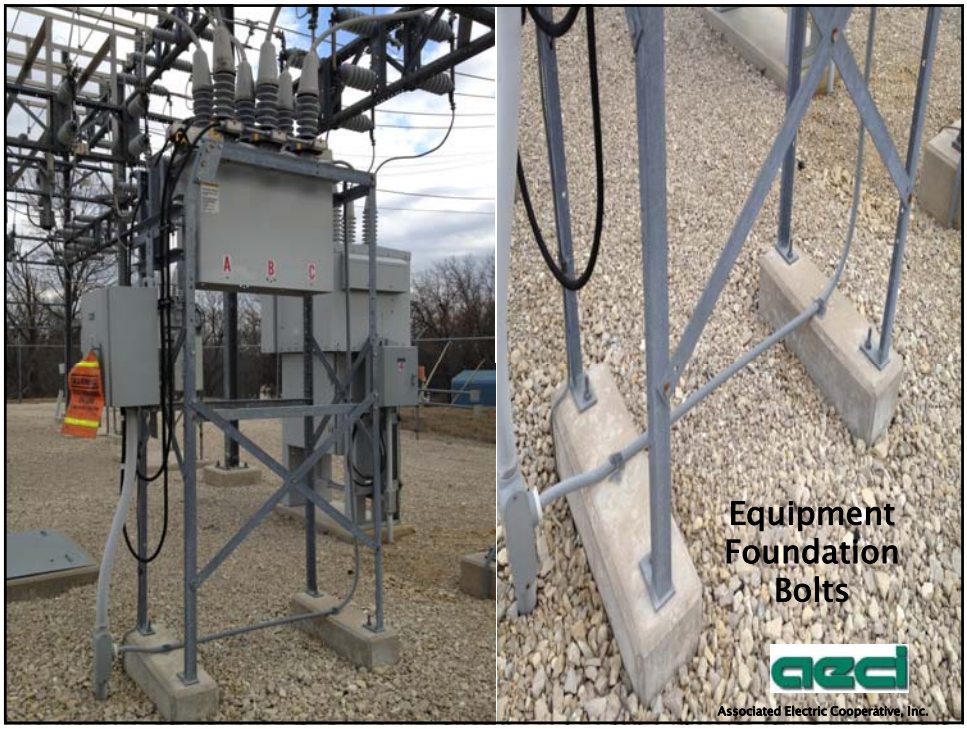
A B C
Equipment
Foundation
Bolts
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Equipment
Foundation
Bolts
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2
12/01/2011
D.C. Supply
Battery
03/02/2012
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Relay Control
Panels
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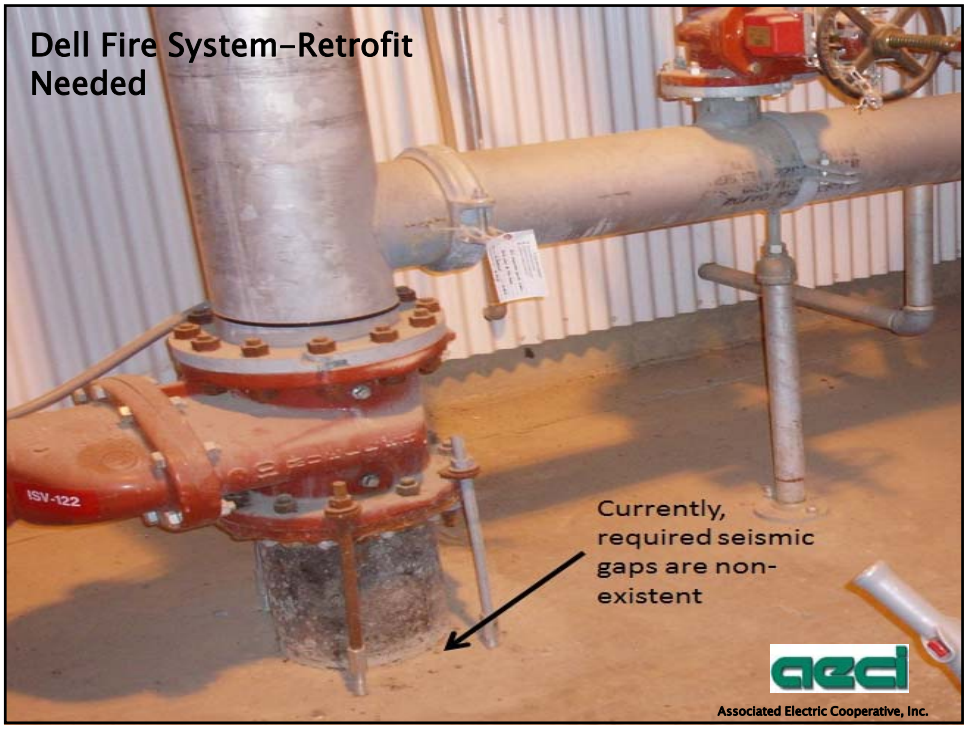
Dell Fire System–Retrofit Needed
ISV-122
Currently, required seismic gaps are non-existent
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Future Plant Design
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Future Transmission Line Design
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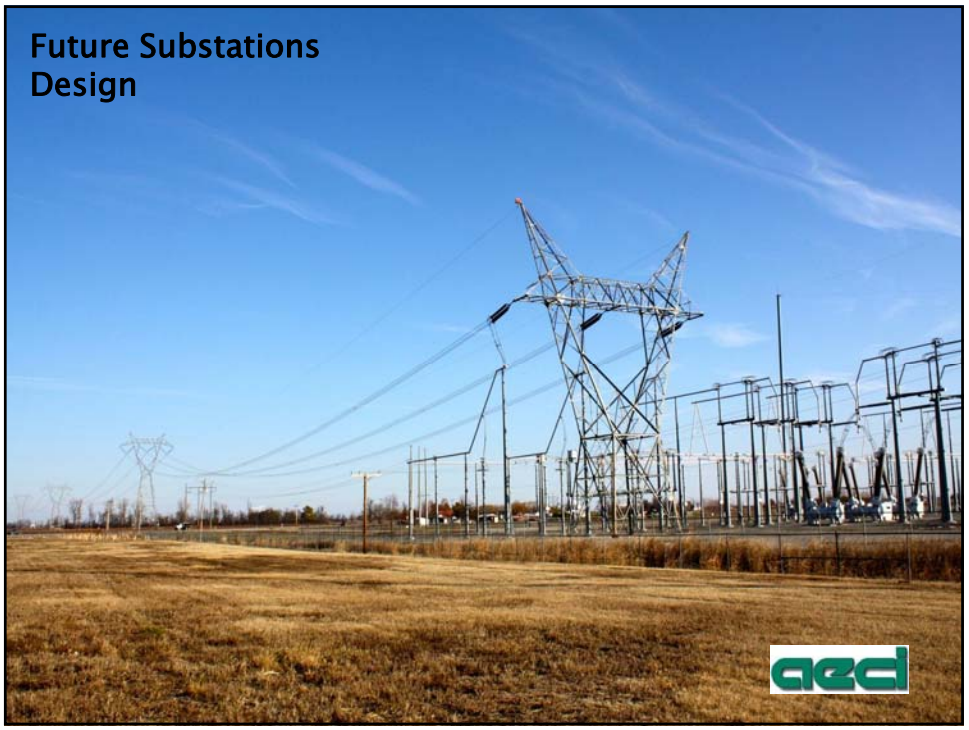
Future Substations
Design
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CONCLUSIONS

- Known impacts from prior events can guide preventive measures prioritization for Seismic Designs
- Design Requirements for Electric Facilities are essential to minimize expected earthquake impacts
- Critical Electric Grid facilities may in the future be subject to FERC earthquake measures (Currently do not exist)
- State Public Utility Commission (PUC) requirements may be implemented in the future

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